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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/593,444	02/05/2007	Makiko Kitazoe	029567-00011	8995

4372 7590 09/15/2009

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EXAMINER	
MILLER, JR, JOSEPH ALBERT	

ART UNIT	PAPER NUMBER
1792	

NOTIFICATION DATE	DELIVERY MODE
09/15/2009	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/593,444	KITAZOE ET AL.	
	Examiner	Art Unit	
	JOSEPH MILLER JR	1792	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 August 2009*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-18* is/are pending in the application.

4a) Of the above claim(s) *1-7* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *8-18* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

Applicant's election of claims 8-18 in the reply filed on 08/04/2009 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 8-18 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 8 recites the limitation "each unit layer". There is insufficient antecedent basis for this limitation in the claim.

With applicant's amendment and failure to define "unit layer", the claim is indefinite as written. Their is no indication of how the unit layer is specifically formed or how it differs from one cycle. Applicants have not defined a cycle or a unit layer with sufficient specificity to make claim clear as written.

Claim Objections

Claim 9 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Claim 9 requires "repeating one surface treating step and other surface treating step a plurality of times during one cycle" while claim 8 requires "repeating one of the one surface treating step and the other surface treating step during one cycle". Claim 9 does not further limit claim 8 since by "repeating" the steps as in claim 8 they are being performed a plurality of times.

Claim Rejections - 35 USC § 103

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 8, 9, 11, 13, and 15-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477) in view of Mase (5,103,287) and Raaijmakers (2002/0052124).

Yamoto teaches the formation of a silicon nitride film using silane, ammonia, and hydrogen gases flowed to a substrate, after being activated by a catalyst [0148]. Yamoto teaches a hydrogen gas treatment step after film formation (the silane and

ammonia are turned off and it is clear that the hydrogen is still flowing), the purpose of the hydrogen flow is to purge the other reactants [0149] but the selection of hydrogen is linked to performance of the catalyst body [0021].

Yamoto does not (explicitly) teach the formation of a multi-cycle film for the formation of a multi-layer film of a single type (i.e. a multi-layered SiN film) wherein the second treatment is not a subsequent deposition step.

Raaijmakers teaches the formation of a silicon nitride film [0135-0137] followed by a densification with ammonia (to further nitride the film) [0138].

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of an ammonia anneal for a SiN film as taught by Raaijmakers with the SiN film formation process of Yamoto because it would allow for a denser and more heavily nitrided film [Raaijmakers, 0138].

Yamoto in view of Raaijmakers teaches the formation of a SiN film with an exposure to hydrogen followed by an exposure to a second treatment, but does not teach repetition of the process cycle.

Mase teaches that a multi-layered silicon nitride film is known (col 5, lines 1-15).

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the teaching of a multi-layer silicon nitride film as taught by Mase to the silicon nitride film forming technique of Yamoto in view of Raaijmakers because it would ensure a denser film because each layer of a composite would be subject to the further nitriding and densification treatment. It would be obvious that the nitriding element used in the anneal would be more effective in carrying out multiple depositions

and nitridation/anneals versus the case where a thicker film is deposited followed by a nitridation/anneal of the complete structure.

Regarding claim 9, it would be obvious to repeat the treatment steps to effect a usable film. In instant case, since Yamoto teaches a hydrogen purge to remove the ammonia, it would be obvious to perform another hydrogen purge after the ammonia "other" treatment step/densification; this step may then lead to the undesired addition of more hydrogen. It would be obvious to repeat the steps as desired until the film reached a desired composition.

Regarding claim 11, the discharge of chemicals from the vacuum chamber [0149] taught by Yamoto is a vacuum pump [0065].

Regarding claim 13, it is inherent that there is hydrogen in the films being deposited with hydrogen containing precursors.

Regarding claim 15, Yamoto teaches the use of ammonia and silane.

Regarding claim 16, Raaijmakers teaches the use of ammonia during the anneal.

Regarding claim 17, Yamoto teaches the deposition of a silicon nitride film using ammonia and Raaijmakers teaches an ammonia anneal/nitridation.

Regarding claim 18, the ammonia anneal may be the last step in the process of one cycle, as described above.

Claims 12 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477)) in view of Mase (5,103,287) and Raaijmakers

(2002/0052124) as applied to claim 8 above in further view of Wang (2004/0121085) and Dip (2005/0066892).

The teachings of Yamoto in view of Mase and Raaijmakers are described above, teaching the use of hydrogen to treat a deposited film as one treatment step and the use of adding a thin-film component (silane gas) as the "other" surface treating step, but not specifically where the one surface treating step is a step of extracting a surplus thin film component.

Wang teaches a method of forming a silicon nitride film (abstract). Wang teaches the deposition of silicon nitride using chlorine-containing gases and ammonia [0025-0026]. Wang teaches that the films may be treated with a nitrogen source gas after deposition [0028] followed by exposure to hydrogen radicals (including the use of hydrogen gas) after the nitrogen exposure step [0033], the hydrogen radicals being formed by a hot wire process and used when a chlorinated and/or organo silicon precursor is used [0030]. Wang teaches that the hydrogen radicals can penetrate less than 100 angstroms deep into the film [0035] and therefore if a thicker film is required, multiple layers should be deposited in order to achieve a desired thickness.

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of HCD as a silane source as taught in the SiN film forming method of Wang to the SiN deposition method of Yamoto as it would improve the step coverage of the layer [0024].

When using such a precursor, the excited hydrogen purge would inherently act as a "step of extracting a surplus thin-film component" as taught by Wang [0020].

To meet claim requirements, one would also apply the HCD precursor to the "other" surface treatment step. It would have been obvious to apply the same precursor for the silicon nitride and polycrystalline silicon films as it would simplify chamber/gas supply requirements. Dip teaches that it is possible to form a polycrystalline silicon film using HCD [0001-2].

Regarding claim 14, Yamoto does not teach the use of a nitrogen gas and a rare gas instead of hydrogen. Wang teaches that ammonia (i.e. rare gas) and nitrogen may be used instead of hydrogen [0032].

Claims 8-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yamoto (2002/0104477) in view of Wang (2004/0121085).

Yamoto teaches the formation of a silicon nitride film using silane, ammonia, and hydrogen gases flowed to a substrate, after being activated by a catalyst [0148]. Yamoto teaches a hydrogen gas treatment step after film formation (the silane and ammonia are turned off and it is clear that the hydrogen is still flowing), the purpose of the hydrogen flow is to purge the other reactants [0149] but the selection of hydrogen is linked to performance of the catalyst body [0021].

Yamoto does not (explicitly) teach the formation of a multi-cycle film for the formation of a multi-layer film of a single type (i.e. a multi-layered SiN film) wherein the second treatment is not a subsequent deposition step.

Wang teaches a method of forming a silicon nitride film (abstract). Wang teaches the deposition of silicon nitride using chlorine-containing gases and ammonia [0025-0026]. Wang teaches that the films may be treated with a nitrogen source gas after deposition [0028] followed by exposure to hydrogen radicals (including the use of hydrogen gas) after the nitrogen exposure step [0033], the hydrogen radicals being formed by a hot wire process and used when a chlorinated and/or organo silicon precursor is used [0030]. Wang teaches that the hydrogen radicals can penetrate less than 100 angstroms deep into the film [0035] and therefore if a thicker film is required, multiple layers should be deposited in order to achieve a desired thickness.

It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the post-SiN film formation treatments of Wang (nitrogen followed by hydrogen) to the hot wire SiN film formation technique of Yamoto because the nitrogen step would increase the N/Si ratio and reduce hydrogen [0028] and the hydrogen treatment step would remove chlorine from the film [0029-0032].

The nitrogen then hydrogen treatment steps of Wang would follow the hydrogen purge of Yamoto. Because the hydrogen purge of Yamoto includes maintaining the temperature of the catalyst, the hydrogen would be available as an active species.

It would be obvious to repeat the steps, as taught by Wang, so that a complete SiN could be formed with effective removal of the chlorine

Regarding claims 8 and 9, it would be obvious to repeat the treatment steps to effect a usable film. The repetition of treatments and anneals is well known in the deposition art. In instant case, because the hydrogen treatment step would potentially

leave more hydrogen than is desired in the film, it would be obvious to re-treat with a nitrogen treatment.

Regarding claim 10, Wang teaches continuous formation of the film including treatment steps for a number of layers [0037].

Regarding claim 11, Yamoto teaches the discharge of the gases from the process chamber [00149] taught by Yamoto is a vacuum pump [0065].

Regarding claim 12, the nitrogen step adds nitrogen to the film and the hydrogen step depletes chlorine (or carbon) from the film.

Regarding claim 13, Wang teaches that the hydrogen treatment may include nitrogen gas and therefore the final step includes a film component.

Regarding claim 14, Wang teaches the use of ammonia instead of hydrogen (i.e. reading on 'rare gas' required in claim) and nitrogen, helium or argon.

Regarding claim 15, Yamoto teaches deposition using silane and ammonia. Wang teaches the use of hexachlorodisilane (HCD) as a silane source gas [0025]. It would have been obvious to someone of ordinary skill in the art at the time of the invention to apply the use of HCD instead of silane as a viable alternative and to allow for improved step coverage of the resulting film [Wang, 0024].

Regarding claim 16, Wang teaches the use of ammonia (hydride of nitrogen) as a surface treatment gas.

Regarding claim 17, all limitations are taught as per Yamoto in view of Wang as described above regarding claims 8 and 14.

Regarding claim 18, the process as taught by Wang is with an ammonia treatment after the nitrogen treatment.

Response to Arguments

Applicants have overcome objections to the specification and claims, as well as 112 rejections with amendments but have introduced new 112 rejections.

Applicant's arguments filed 08/04/2009 have been fully considered but they are not persuasive. Applicants amended claim 8 and argue that Yamoto fails to teach or suggest repeating the surface treatment steps during one cycle. Examiner contends that applicants amendment fails to limit the contents/composition of “one cycle” appreciably to overcome any of the 103 prior art rejections.

It **is** required by amended claim that the treatment steps are repeated per one cycle and therefore the 102 rejection over Yamoto has been overcome. It is specifically noted that the interpretation of "another surface treating step” could still be interpreted as a deposition step, however. Alternative rejections could be made over Yamoto for example in view of Mase (i.e. without Raaijmakers) which would describe the repetition of the steps to form a film and then treat with hydrogen but will not be made due to some redundancy they would introduce.

The one cycle may be interpreted as including repeated (both) surface treating steps **but** does **not** preclude repetition of the film forming step within one cycle. It is

noted that applicants do not specifically limit the definition of "one cycle" or, for that matter, the definition of a “unit layer”.

Examiner’s interpretation is based on the requirement in the MPEP to broadly interpret claims. The teachings of Yamoto in view of Mase and Raaijmakers teach multiple iterations. Based on examiner’s interpretation that the cycle may include multiple "film-forming” steps, the multiple iterations read on “one cycle” and, simultaneously the use of a plurality of cycles. There is no discernible difference as instant claims are written between one cycle and the repetition of cycles.

Regarding applicants response regarding Yamoto in view of Wang, applicant does not specifically argue any point over the applicant of Wang to Yamoto. Examiner maintains that Wang suggests the use of multiple treatment steps and multiple layers to form the film and therefore teaches instant claim limitations.

Applicants arguments over the application of Dip and Wang to Yamoto are limited to the assertion that the prior art does not cure the purported deficiencies in Yamoto; the 102 has been removed over Yamoto but Dip and Wang are applied (due to amendment) to the 103 rejection over Yamoto in view of Raaijmakers and Mase.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSEPH MILLER JR whose telephone number is (571)270-5825. The examiner can normally be reached on Mon-Thurs, 7am-4pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Timothy Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JOSEPH MILLER JR/
Examiner, Art Unit 1792

/Timothy H Meeks/
Supervisory Patent Examiner, Art Unit 1792